

Credence Goods, Efficient Labelling Policies, and Regulatory Enforcement

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- In many instances, consumers are willing to pay more for an unobservable attribute of a product.
- A hidden attribute may have environmental or health consequences. Such products are called *credence goods*.
- However, when these desirable attributes are private information, even "non-green" firms can pretend to be a "green" firm.
- One possible way to solve this problem is the use of eco-labels by firms.

- The authors investigate optimal labelling rules (i) when the labelling process is reliable and (ii) when the process can be misused by dishonest firms. Specifically,
 - Which *type* of producers should label their product
 - What *method* of labelling should be followed

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The model

- Two types of vertically differentiated good
 - Brown(type 1) and Green(type 2)
- perfect competition with free entry and exit
- the fixed cost K_i and the variable cost $\frac{1}{2}c_i q_i^2$ for type i good
 - Assume $K_2 > K_1$ and $c_2 > c_1$
- The profit function is given by $\pi_i = p_i q_i - K_i - \frac{1}{2}c_i q_i^2$
 - Using the FOC and the zero profit condition, we have

$$p_i^* = \sqrt{2c_i K_i} \quad \text{and} \quad q_i^* = \sqrt{2K_i/c_i}$$

The model

- With complete information, consumers can observe the good's type.
- Each consumer inelastically demands one unit of the good.
- Consumers are willing to pay $(M - \theta)$ dollars for the type 1 good, and M dollars for the type 2 good.
 - θ represents a measure of distaste for the brown good
 - $\theta \sim U[0, 1]$
- A consumer is indifferent between buying good of either type when $M - \theta - p_1^* = M - p_2^*$. Solving for θ ,

$$\theta = p_2^* - p_1^* = \sqrt{2c_2K_2} - \sqrt{2c_1K_1}$$

- We assume $0 < \sqrt{2c_2K_2} - \sqrt{2c_1K_1} < 1$ such that both types of the good are produced in equilibrium.

Comparison with the first best outcome

- Now, let's compare the above result with the socially optimal outcome. The social welfare is given by

$$\begin{aligned} W &= \int_0^\theta (M - \theta) d\theta + \int_\theta^1 M d\theta - \left(K_1 + \frac{1}{2} c_1 q_1^2 \right) \theta / q_1 \\ &\quad - \left(K_2 + \frac{1}{2} c_2 q_2^2 \right) (1 - \theta) / q_2 \\ &= M - \frac{1}{2} \theta^2 - \left(K_1 + \frac{1}{2} c_1 q_1^2 \right) \theta / q_1 - \left(K_2 + \frac{1}{2} c_2 q_2^2 \right) (1 - \theta) / q_2 \end{aligned}$$

- The government maximizes W with respect to θ and q_i . Then, the socially optimal levels of outputs and market share are given by

$$q_i^W = \sqrt{2K_i/c_i} \quad \text{and} \quad \theta^W = \sqrt{2c_2 K_2} - \sqrt{2c_1 K_1}$$

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Labelling by brown firms

- Suppose third party labelling is made mandatory for the brown firms.
- The profit of each brown firm is given by

$$\pi_1 = p_1 q_1 - K_1 - 1/2 c_1 q_1^2 - l_1 q_1$$

- The FOC and the zero profit condition give

$$p_1^A = \sqrt{2c_1 K_1} + l_1 = p_1^* + l_1 \quad \text{and} \quad q_1^A = \sqrt{2K_1/c_1} = q_1^*$$

- The market share of the brown good declines to

$$\theta^A = p_2^* - p_1^A = \theta^* - l_1$$

- To rule out corner solutions, assume the labelling cost are such that

$$l_1 < \sqrt{2c_2 K_2} - \sqrt{2c_1 K_1} < 1 - l_2$$

Social welfare in Case A

- The social welfare is given by

$$\begin{aligned}W^A &= \int_0^{\theta^A} (M - \theta) d\theta + \int_{\theta^A}^1 M d\theta - \left(K_1 + \frac{1}{2} c_1 (q_1^*)^2 + h_1 q_1^* \right) \frac{\theta^A}{q_1^*} \\ &\quad - \left(K_2 + \frac{1}{2} c_2 (q_2^*)^2 \right) \frac{1 - \theta^A}{q_2^*} \\ &= M + \frac{1}{2} (\theta^A)^2 - \sqrt{2c_2 K_2}\end{aligned}$$

- We can see that the social welfare declines

$$W^* - W^A = h_1 \left(\theta^* - \frac{1}{2} h_1 \right) > 0$$

Labelling by green firms and social welfare

- The equilibrium price and quantity when green firms label are

$$p_2^B = p_2^* + l_2 \quad \text{and} \quad q_2^B = q_2^*$$

- The market share of brown firms increases to

$$\theta^B = p_2^B - p_1^* = \theta^* + l_2$$

- The social welfare when green firms label is

$$\begin{aligned} W^B &= \int_0^{\theta^B} (M - \theta) d\theta + \int_{\theta^B}^1 M d\theta - \left(K_1 + \frac{1}{2} c_1 (q_1^*)^2 \right) \frac{\theta^B}{q_1^*} \\ &\quad - \left(K_2 + \frac{1}{2} c_2 (q_2^*)^2 + l_2 q_2^* \right) \frac{1 - \theta^B}{q_2^*} \\ &= M + \frac{1}{2} (\theta^B)^2 - \sqrt{2c_2 K_2} - l_2 \end{aligned}$$

- Compared to the case of complete information, the social welfare declines: $W^* - W^B = l_2(1 - \frac{1}{2}l_2 - \theta^* > 0)$

Comparison between Case A and B

- We have $W^B \geq W^A$ iff $\theta^* \geq \frac{l_1^2 - l_2^2 + 2l_2}{2(l_1 + l_2)} \equiv \hat{\theta}$

Proposition 1

Provided labelling is done truthfully, third party labelling under incomplete information should be undertaken by green firms if and only if market share of the brown good in the first best case, θ^* , exceeds the threshold value $\hat{\theta}$, as defined above.

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The model Setup

- The brown firms can cheat.
- The government randomly monitors m number of green firms.
- The amount of fine when caught cheating is F .
- A firm does not cheat if its expected net profit from cheating is zero.
- There are 3 options with respect to labelling policy
 - third party labelling by the brown firms
 - third party labelling by the green firms
 - self-labelling

Equilibrium: third party labelling by the brown firms

- A brown firm can pretend to be green by not obtaining a label from the labelling agency.
- The profit of a brown firm by not obtaining a label is

$$\tilde{\pi}_1^A = p_2^A q_1 - K_1 - \frac{1}{2} c_1 q_1^2$$

- Since $p_2^A = p_2^* = \sqrt{2c_2 K_2}$, the maximized profit is

$$\tilde{\pi}_1^A = (c_2 K_2 - c_1 K_1) / c_1 > 0$$

- The optimal number of firms the government has to inspect to ensure no cheating is

$$\frac{m^A F}{n^2} = \frac{\tilde{\pi}_1^A (n^2 - m^A)}{n^2} \implies m^A = \frac{\tilde{\pi}_1^A (1 - \theta^A)}{\tilde{\pi}_1^A + F} \sqrt{\frac{c_2}{2K_2}},$$

- The social welfare is $\tilde{W}^A = M + \frac{1}{2} (\theta^A)^2 - \sqrt{2c_2 K_2} - hm^A$

Equilibrium: third party labelling by the green firms

- A brown firm can pretend to be a green firm by carrying a fake label.
- Assume that faking a label is costless to the brown firms.
- In this case, the maximized profit of a cheating firm is given by

$$\tilde{\pi}_1^B = \tilde{\pi}_1^A + l_2 \left(\sqrt{2c_2K_2} + \frac{1}{2}l_2 \right) / c_1$$

- Similarly, the number of firms that need to be inspected by the government is

$$m^B = \frac{\tilde{\pi}_1^B (1 - \theta^B)}{\tilde{\pi}_1^B + F} \sqrt{\frac{c_2}{2K_2}}$$

- The social welfare is $\tilde{W}^B = M + \frac{1}{2} (\theta^B)^2 - \sqrt{2c_2K_2} - l_2 - hm^B$

Equilibrium: self-labelling

- Assume that self-labelling is costless.
- The price of the type i good remains at p_i^* and the market share of the brown firm stays at θ^* .
- The profit of a cheating firm is $\tilde{\pi}_1^S = p_2^* q_1 - K_1 - \frac{1}{2} c_1 q_1^2$. If maximized, the profit is given by $\tilde{\pi}_1^S = (c_2 K_2 - c_1 K_1) / c_1 = \tilde{\pi}_1^A$
- The number of firms that need to be inspected is

$$m^S = \frac{\tilde{\pi}_1^A (1 - \theta^*)}{\tilde{\pi}_1^A + F} \sqrt{\frac{c_2}{2K_2}}$$

- The social welfare is $\tilde{W}^S = M + \frac{1}{2} (\theta^*)^2 - \sqrt{2c_2 K_2} - hm^S$.

Comparison: Third party labelling by green VS. brown firms

- Two opposing effects exist under the third party labelling by green firms.
 - It increases the incentive of a brown firm to cheat (*incentive-to-cheat effect*) $\implies m^B$ must go up!
 - It decreases the green firms' market share and results in fewer numbers of green firms. (*market share effect*)
 - If *incentive-to-cheat effect* dominates *market share effect* $\implies m^B > m^A$

Proposition 2

When the government has to monitor in order to prevent brown firms from cheating, third party labelling should be done by green firms (i.e.

$$\tilde{W}^B \geq \tilde{W}^A) \text{ if and only if } \theta^* \geq \hat{\theta} + h(m^B - m^A)/(l_1 + l_2) \equiv \hat{\hat{\theta}}$$

Comparison: Self-labelling VS. Third party labelling by brown firms

- The cheating incentive for the brown firms is the same. ($\tilde{\pi}_1^A = \tilde{\pi}_1^S$)
- However, the third party labelling by the brown firms increases the market share of the green firms $\implies m$ must go up!
- It also imposes a labelling cost on society

Proposition 3

When firms can cheat and monitoring is required for enforcement of labelling rules, self-labelling is better than third party labelling by brown firms, as it imposes less (labelling and monitoring) costs on society.

- To compare the social welfare,

$$\tilde{W}^S - \tilde{W}^A = h_1 \left(\theta^* - \frac{1}{2} h_1 \right) + h l_1 \frac{\tilde{\pi}_1^A}{\tilde{\pi}_1^A + F} \sqrt{\frac{c_2}{2K_2}} > 0$$

Comparison: Self-labelling VS. Third party labelling by green firms

- The third party labelling by green firms have three effects on welfare
 - *Incentive-to-cheat effect* by the brown firms
 - *Market share effect* as the government has to inspect fewer firms
 - labelling cost on society
- The welfare difference is given by

$$\tilde{W}^S - \tilde{W}^B = l_2 \left(1 - \theta^* - \frac{1}{2}l_2 \right) + h \left(m^B - m^S \right)$$

Comparison: Self-labelling VS. Third party labelling by green firms

Proposition 4

If the government has to inspect more firms when it imposes third party labelling on the green firms than when it imposes self-labelling (i.e. $m^B > m^S$), then the government should choose the self-labelling option. Self-labelling is also optimal if m^S slightly exceeds m^B . Only if m^S is sufficiently larger than m^B so that the lower monitoring cost compensates the additional labelling cost, should the government opt for third party labelling by green firms rather than self-labelling.

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Summary

- When firms are honest, self-labelling leads to the first best outcome and is the most preferable.
- Under the same setting, the government should impose third party labelling requirement on the green firms iff $\theta^* \geq \hat{\theta}$
- When firms can cheat, the third party labelling by the green firms should be imposed iff $\theta^* \geq \hat{\theta}$
- Self-labelling is always preferable to the third party labelling by the brown firms.
- The third party labelling by the green firms is preferable to self-labelling if fewer firms have to be monitored and the monitoring cost is very high.